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# STUDIES ON THE EFFECT OF COMBINATION OF BIOREGULATORS AND GROWTH REGULATORS ON FLOWERING AND YIELD OF MANGO (*Mangifera indica* L) cv. BANGANPALLI

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***ABSTRACT***

***An experiment on the effect of bioregulators and growth regulators zinc sulphate @ 0.1%, paclobutrazol (PBZ) @ 3ml.m$^{-1}$ canopy diameter, Napthalein acetic acid (NAA) @ 80 ppm, gibberilic acid ($GA_3$) @ 20 ppm, 1-2-chloro-4pyridyl-3-phenyl urea (CPPU) @ 10ppm, potassium sulphate ($K_2SO_4$) @ 1% , their combinations utilizing BBCH scale of mango was conducted on flowering, fruit set and yield of mango cv. Banganpalli. Paclobutrazol alone or in combinations with other bioregulators has significantly increased the percent of flowering, panicle length and breadth when compared to control. Significantly highest number of fruits.panicle$^1$, fruits.tree$^1$ and yield (23.7 % over control) were recorded in paclobutrazol alone followed by Napthalein acetic acid (20.96% increases in yield over control).***

***KEYWORDS: Bioregulators and Growth Regulators, Fruit Set and Yield of Mango***

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**Original Article**

## INTRODUCTION

Mango (*Mangifera indica* L.) is the premier fruit among the tropical fruits. India is the largest producer of mango in the world. The fruits of mango are valued because of its excellent flavor, appealing aroma, delicious taste, attractive shades of colour and nutritive value, which has attracted the world market. . In Telangana, mango occupies an area of 2.10 lakh ha, with a production of 1,894.9 M.T with a productivity of 9.0 T. ha$^{-1}$ (Anon, 2013). Although, India is the leading mango producing country, the development of mango orchards as an established industry has remained a distant goal and per hectare yields (2.45 t ha$^{-1}$) are low in spite of great potential (Anon, 2013). There are number of reasons for the poor productivity, of which alternate or biennial bearing habit of most of the choicest commercial varieties of India is one of the important factors. The flowering phenomenon in mango appears to be a complex one. Research workers engaged in the field have not appreciably established the critical factors responsible for this phenomenon. Recommendations of horticultural scientists have not paved the way for a satisfactory solution to this problem. However, on account of continued research, this problem is better understood now than before. Since, most of the earlier studies were aimed at developing agro techniques to promote regular cropping, enough knowledge on the physiology of flowering is lacking. However, the studies of Davenport (2007), on the evidence of involvement of leaf generated floral stimulus have opened up new vistas in the direction of research on physiology of flowering in mango.

Various chemicals and growth regulators application have been standardised for enhancing vegetative

growth and uniform flowering in mango. Application of Zinc Sulphate ($ZnSO_4$) @ 0.4% promoted vegetative growth as indicated by plant height, girth, and spread of young plants (Banik and Sen 1997). Application of Gibberellic acid ($GA_3$) increased vegetative growth, number of secondary branches (Singh and Rajput 1990). Paclobutrazol (PBZ) @ 3ml.m$^{-1}$ of canopy diameter at 120 days before bud break was found to improve flowering and yield in mango cv. Banganpalli (Bhagwan *et al.,* 2011). Napthalein Acetic Acid (NAA) @ 80 ppm spray at 30 days before flowering was found to improve flowering in mango (Davenport, 2007). Application of CPPU (10 ppm) gave the best result in terms of increasing fruit retention, number of fruits per cluster and per plant, weight of one fruit, fruit volume and leaf area in mango cv. Arumanis (Notomedijo 1999).

Knowledge of the periodic biological events of a particular crop – bud breaks, flushing, flowering, and fruit development is an important tool for its agronomical management in relation with climate change (Hernandez Delgado *et al.,* 2011). Bleiholder *et al.* 1989 developed a two-digit decimal coding system for angiosperms, the BBCH-scale (Biologische Bundesantalt, Bundessortenamt und Chemische Industrie). Later three digits “extended BBCH-scale” (Hack *et al.,* 1992) was proposed for certain crops like grains, rape and sunflower, vegetables, pome and stone fruits, citrus, grape, strawberry, pomegranate, coffee, olive, Musaceae, persimmon, cherimoya. Keeping above fact in view, the phenological studies were conducted to asses BBCH- scale for mango cultivars like Totapuri (Shailender rajan *et al.,* 2011). The BBCH scale distinctly separates the various vegetative flushes occurring in the mango, as well as the terminal and axillary flowerings. All of which is important for the correct timing of general orchard management, particularly for disease and pest management, physiological disorders and weed control, flowering inhibition and effectiveness of fertilizers and PGRs application (Hernandez Delgado *et al.,* 2011).

## MATERIALS AND METHODS

The experiment was conducted on ten years old well grown, uniform statured trees of mango cv. Banganpalli. Trees are spaced with 8m and planted in square system. The statistical design adopted was Randomised block design with 8 treatments which were replicated thrice. Paclobutrazol concentration was calculated based on the diameter of the tree, and applied @ 3 ml per metre of canopy diameter (Bhagwan *et al*., 2011). The required paclobutrazol was dissolved in 10 litre of water. Eighty milligrams of Napthalein acetic acid (NAA) was dissolved in 50 ml of ethanol and diluted it in 1 litre of water to get 80 ppm of NAA. Ten gm of potassium sulphate ($K_2S0_4$) was dissolved in 1 litre of water to get 1% of $K_2SO_4$. Twenty mg of (1-2-chloro-4pyridyl-3-phenyl urea) CPPU was dissolved in 50 ml of ethanol and diluted it in 1 litre of water to get 20 ppm of CPPU. Twenty mg of gibberllic acid ($GA_3$) was dissolved in 50 ml of ethanol and diluted in 1 litre of water to get 20 ppm of $GA_3$. 0.1 gram of zinc sulphate ($ZnSO_4$) was dissolved in 1 litres of water to get 0.1% of $ZnSO_4$. Data on percent flowering, panicle length and breath, fruitset. panicle$^{1}$, fruits. Tree$^{1}$ and yield were recorded. Twenty shoots were randomly tagged (from North, South, East and West directions) and no of tagged shoots which had flowered was recorded and expressed as percentage of flowering. The panicle length and breadth, fruit set of ten randomly selected shoots were recorded the mean was calculated. The total number of fruits harvested.tree$^{-1}$ was counted after harvest and expressed as number of fruits.tree$^{-1}$.The average fruit weight was computed by dividing the total yield (kg per tree) and number of fruits per tree of the respective treatment.

## RESULTS AND DISCUSSIONS

### Flowering Parameters

The results on percent flowering (%) of mango cv. Banganpalli sprayed with different combinations of

bioregulators and growth regulator sprays are presented in the table 1.

There was significant difference among combination of bioregulators and growth regulator sprays application with respect to percent flowering (%).Trees sprayed with paclobutrazol (91.67) has significantly increased the percent flowering which was on par with application of Napthalein acetic acid (73.33) and gibberillic acid (75). Minimum flowering percent was recorded in untreated control (35), followed by application of potassium sulphate + (1-2-chloro-4pyridyl-3-phenyl urea) (45) which were on par with application of (1-2-chloro-4pyridyl-3-phenyl urea) (61.67), zinc sulphate + paclobutrazol (56.66), zinc sulphate + (1-2-chloro-4pyridyl-3-phenyl urea) (55), potassium sulphate + gibberillic acid (51.66) and potassium sulphate + Napthalein Acetic Acid(50).

Paclobutrazol application and Napthalein acetic acid spray has significantly increased the per cent flowering compare to control (Table 1). However, the paclobutrazol was significantly more effective in increasing the flowering percentage. Gibberellins, a group of plant growth hormones were reported to be inhibitory to flowering (Kachru *et al*., 1971), in mango and the available evidence suggests the flower promotive effect of paclobutrazol in mango due to its anti - gibberellin activity (Quinlan and Richardson, 1984). Hence, in the present investigation the increase in the percent (%) flowering of mango by paclobutrazol was due to its anti - gibberellin activity. Increase in per cent flowering (%) by application of Paclobutrazol was earlier reported by Rao *et al.* (1997) in mango cv. Alphonso, Shinde *et al.* (2001) also reported similar increase in per cent flowering (%) by application of Paclobutrazol in mango cv. Alphonso. Zora Singh *et al.* (2000) also reported similar increase in per cent flowering (%) by application of Paclobutrazol in mango. Burondkar *et al.* (2000) reported similar increase in per cent flowering (%) when the trees were sprayed with paclobutrazol in mango cv. Alphonso. Vijayalaxmi and Srinivasan (2000) also reported similar increase in per cent flowering (%) by application of Paclobutrazol in mango cv. Alphonso. Similar increase in per cent flowering (%) by application of Paclobutrazol was obtained by Kumar Raj *et al.* (2005) in mango cv. Banganpalli and by Orwintinee *et al.* (2008) in mango cv. Irwin. The napthalein acetic acid spray has also significantly increased the flowering in mango cv. Banganpalli in the present investigation when compared with the control. Increase in flowering with spraying of Napthalein acetic acid was reported in mango cv. Succary Abiad (Wahdan *et al*., 2011). Napthalein acetic acid which is considered as flowering hormones in some crops might have increased the latent flowering factors in the mango and resulted in overall increase in flowering in mango cv. Banganpalli when compared to control in the present investigation.

The results on panicle length after application of different combination of bioregulators and growth regulator sprays are presented in the table 2. There is significant difference among different combination of bioregulators and growth regulator sprays with respect to panicle length. Minimum panicle length was recorded in untreated control (19.30), followed by application of (1-2-chloro-4pyridyl-3-phenyl urea) (20.88), gibberellic acid (21.81), zinc Sulphate + gibberellic acid (24.32), potassium sulphate + gibberellic acid (24.34) and zinc sulphate + napthalein acetic acid (24.97).Trees sprayed with paclobutrazol (30.57) has significantly increased the panicle length compared to control (19.30).

Paclobutrazol has significantly increased the panicle length compare to control (Table 2). Similar increase in panicle length with the application of paclobutrazol in mango was reported by Desai and Chundawat (1994) in mango. Vijayalaxmi and Srinivasan (1998) also earlier reported increase in panicle length in mango cv. Alphonso when trees treated with paclobutrazol @10 ml.tree$^{-1}$.

The results on panicle breadth after application of different combination of bioregulators and growth regulator

sprays are presented in the table 3. There is significant difference among different combination of bioregulators and growth regulator sprays with respect to panicle breadth. Trees sprayed with paclobutrazol (22.2) has significantly increased panicle breadth which was on par with application of zinc sulphate + (1-2-chloro-4pyridyl-3-phenyl urea) (21.82) and zinc sulphate + paclobutrazol (18.51) compared to control (8.33).

Paclobutrazol could able to increase the panicle breadth compare to control and napthalein acetic acid (Table 3). However, Winston (1992) in mango cv. Kensington and Orwintinee *et al.* (2008) in mango cv. Irwin reported that the panicles of paclobutrazol treated trees were considerably shorter than those of control trees. The discrepancy in the finding of present investigation to the earlier reports regarding panicle may be due to varietal change, time of applications and dosage of paclobutrazol. However, increase in panicle length and breadth of paclobutrazol treated trees might be beneficial for increase the number of hermaphrodite flowers per panicle. This may cause for better fruit set over the control.

**Fruit Set Parameters**

The results on fruit set per panicle after application of different combination of bioregulators and growth regulator sprays are presented in the table 4. The data revealed that there is significant difference among different combination of bioregulators and growth regulator sprays with respect to fruit set per panicle of mango. Trees sprayed with paclobutrazol (13.13), zinc sulphate +(1-2-chloro-4pyridyl-3-phenyl urea) (13) have significantly increased fruit set per panicle which were on par with the application of potassium sulphate+ paclobutrazol(12.80), potassium sulphate + napthalein acetic acid(11.33), potassium sulphate + gibberellic acid (10.86), zinc sulphate + gibberellic acid (10.13). However, zinc sulphate+ napthalein acetic acid (8.2), potassium sulphate+(1-2-chloro-4pyridyl-3-phenylurea) (8.33), zinc sulphate + paclobutrazol (8.43) and gibberellic acid (8.86) could not significantly increase the fruit set per panicle.

The prolonged flowering period (Days taken for full flower opening from panicle initiation) might have caused for better fruit set in paclobutrazol treated trees compare to control.

Application of paclobutrazol and zinc sulphate + (1-2-chloro-4pyridyl-3-phenyl urea) increased fruit set panicle$^{-1}$ compared to control and napthalein acetic acid (Table 4). Similar increase in fruit set panicle$^{-1}$ in response to paclobutrazol application was recorded by GoGuey (1990) in cv. Valencin. Increase in fruit set panicle$^{-1}$ in response to paclobutrazol application was earlier reported by Iyer and Kurian (1992) in mango cv. Alphonso. Zora Singh *et al.* (2000) also reported increase in fruit set panicle$^{-1}$, when trees were treated with paclobutrazol in mango cv. Dashehari. Increase in fruit set panicle$^{-1}$ in response to paclobutrazol application was earlier obtained by Cardenas and Rojas (2003) in mango cv. Tommy Atkins. Kumar Raj *et al.* (2005) also reported increase in fruit set panicle$^{-1}$, when the trees were treated with paclobutrazol in cv. Banganpalli. Increased fruit set panicle$^{-1}$ in response to the application of paclobutrazol was earlier reported by Orwintinee *et al.* (2008) in mango cv. Irwin.

Increase in fruit set panicle$^{-1}$ in response to application of zinc sulphate + (1-2-chloro-4pyridyl-3-phenyl urea) might be due to the increase in fruit set after the application of synthetic cytokinin (1-2-chloro-4pyridyl-3-phenyl urea).

Similar increase in fruit set panicle$^{-1}$ in response to application of (1-2-chloro-4pyridyl-3-phenyl urea) was recorded by Notodemedjo (2000) in mango cv. Arumanis and Burondkar *et al.* (2009) in mango cv. Alphonso. Increase in fruit set panicle$^{-1}$ in response to application of zinc sulphate, was reported by Negi *et al*., (2011) in mango cv. Dashehari.

**Yield Parameters**

The results on total number of fruits produced on a tree after application of different combination of bioregulators and growth regulator sprays are presented in the table 5.

The data revealed that there is significant difference among combination of bioregulators and growth regulator sprays with respect to number of fruits per tree of mango. Trees sprayed with application of paclobutrazol (133) has significantly increased number of fruits per tree which was on par with application of (1-2-chloro-4pyridyl-3-phenylurea) (131.66), zinc sulphate + paclobutrazol (131.33) and potassium sulphate+ paclobutrazol (130.00). Minimum number of fruits per tree was recorded in untreated control (110.66), zinc sulphate + gibberillic acid (112.33) and gibberillic acid (113).

Trees sprayed with paclobutrazol have recorded increase in per cent flowering (Table 1), prolonged days taken for 50% flowering and days taken for full flower opening which inturn increased the fruit set per panicle (Table 4). This increase in fruit set per panicle was responsible for the increase in fruit number in the paclobutrazol sprayed trees in the present investigation. The correlation between intensity of flowering, perfect flowers and better fruit set and subsequent increase in total number of fruits per tree and yield was earlier reported by Burondkar and Gunjate, (1993) in mango. Paclobutrazol application has significantly increased the number of fruits per tree compare to control and napthalein acetic acid spray (Table 5). Similar increase in number of fruits tree$^{-1}$ was earlier reported by Kumar Raj *et al.* (2005) in mango cv. Banganpalli. Increase in number of fruits in response to paclobutrazol application was earlier obtained by Cardenas and Rojas (2003) in mango cv. Tommy Atkins and by Orwintinee *et al*. (2008) in mango cv. Irwin. Kumbhar *et al.* (2007) also reported similar increase in number of fruits in mango cv. Kesar.

The results on fruit weight (gm) of mango cv. Banganpalli sprayed with different combination of bioregulators and growth regulator sprays are presented in the table 6. There was significant difference among different combination of bioregulators and growth regulator sprays application with respect to fruit weight (gm). Trees sprayed with application of napthalein acetic acid (315.67) has significantly increased the individual fruit weight which was on par with application of paclobutrazol (309.33), zinc sulphate + paclobutrazol (309) and potassium sulphate+ napthalene acetic acid (307.33) compared to untreated control (296.67).

There was significant difference among different combination of bioregulators and growth regulator sprays with respect to fruit weight (gm) (Table 6) .Paclobutrazol and NAA were both equally increased the fruit weight. Similar increase in fruit weight was earlier reported by Nav Prem Singh *et al*. (2002) in mango cv. Dasheri treated with 100 ppm of NAA and Wahdan *et al.* (2011) in mango cv. Succary Abiad treated with NAA @ 60 ppm. Paclobutrazol also increased the fruit weight in mango cv. Baneshan (Kumar Raj *et al.* 2005). Increase in fruit weight was earlier reported by Razzaq *et al.* (2013) in kinnow mandarin when the trees were treated with 0.6% zinc sulphate. Similar increase in fruit weight was earlier reported by Burondkar *et al.* (2009) with the application of Potassium sulphate in mango cv. Alphonso.

The results on yield per tree after application of different combination of bioregulators and growth regulator sprays are presented in the table 7. The data revealed that there is significant difference in yield (kg.tree$^{-1}$) among different combination of bioregulators and growth regulator sprays. Trees sprayed with application of paclobutrazol (40.6) have significantly increased the yield per tree which was on par with application of napthalein acetic acid (39.7) and zinc sulphate + paclobutrazol (39.61). Minimum yield was recorded in untreated control (32.82).

Paclobutrazol and NAA were both equally increased the yield. The increase in intensity of flowering, better fruit set and fruit weight in paclobutrazol treated trees have ultimately increased the yield of mango (23.7% over control) in the present investigation. Burondkar and Gunjate (1993) also found similar correlation between flowering, fruit set, fruit weight and yield of mango in response to paclobutrazol application. Similar increase in yield of mango in response to paclobutrazol application was obtained by various workers like Singh and Dhillon (1992) in cv. Kensington pride, Zora Singh and Dhillon (1992) also reported similar increase in yield in cv. Dashehari. Increase in yield of mango in response to paclobutrazol application was obtained by Iyer and Kurian (1992), Ram and Tripathi (1993) in cv. Dashehari. Desai and Chundawat (1994) also reported similar increase in yield in mango cv. Alphonso. Patil and Talathi (1999), Shinde *et al*. (2002) earlier reported similar increase in yield in cv. Alphonso. Increase in yield of mango in response to paclobutrazol application was earlier reported by Kumar Raj *et al*. (2005) in mango cv. Banganpalli. Orwintinee *et al*. (2008) also obtained similar increase in yield in cv. Irwin and Kumbhar *et al*. (2007) reported similar increase in yield in response to paclobutrazol application in mango cv. Kesar.

Similar increase in yield in response to the application of zinc sulphate was reported by Negi *et al*. (2011) in mango cv. Dashehari, Singh *et al*. (2009) in mango, Lolaei *et al*. (2012) in strawberry. Abdollahi *et al*. (2010) also earlier reported similar increase in yield in response to the application of zinc sulphate in Strawberry cv. Selva.

Rawash *et al*. (1998a) in mango and Shinde *et al*. (2002) also earlier reported similar increase in yield in response to the application of napthalein acetic acid in mango cv. Alphonso, Application of napthalein acetic acid increased yield in mango cv. Dashehari (Singh *et al* ., 2005).

**Table 1: Effect of Combination of Different Bioregulators and Growth Regulator Sprays on Percent Flowering of Mango Cv. Banganpalli**

| Treatment | | Mean |
|---|---|---|
| $T_1$: | Gibberilic acid | $75.00^{ab}$ |
| $T_2$: | Napthalein Acetic Acid | $73.33^{ab}$ |
| $T_3$: | Paclobutrazol | $91.67^{a}$ |
| $T_4$: | (1-2-chloro-4pyridyl-3-phenyl urea) | $61.67^{bc}$ |
| $T_5$: | Zinc Sulphate+Gibberilic acid | $48.33^{bc}$ |
| $T_6$: | Zinc Sulphate+Napthalein Acetic Acid | $35.00^{c}$ |
| $T_7$: | Zinc Sulphate+Paclobutrazol | $56.67^{bc}$ |
| $T_8$: | Zinc Sulphate+1-2-chloro-4pyridyl-3-phenyl urea | $55.00^{bc}$ |
| $T_9$: | Potassium Sulphate +Gibberilic acid | $51.67^{bc}$ |
| $T_{10}$: | Potassium Sulphate +Napthalein Acetic Acid | $50.00^{bc}$ |
| $T_{11}$: | Potassium Sulphate +Paclobutrazol | $68.33^{b}$ |
| $T_{12}$: | Potassium Sulphate +1-2-chloro-4pyridyl-3-phenyl | $45.00^{c}$ |
| $T_{13}$: | Control | $35.00^{c}$ |
| **F- test** | | * |
| **S.Em ±** | | 7.32 |
| **CD at (5%)** | | 21.50 |

Figures with same alphabets did not differ significantly. ** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant. Values were compared with respective C.D values

**Table 2: Effect of Combination of Bioregulators and Growth Regulator Sprays on Panicle Length of Mango Cv. Banganpalli**

| Treatment | | MEAN |
|---|---|---|
| $T_1$: | Gibberilic acid | $21.81^{b}$ |
| $T_2$: | Napthalein Acetic Acid | $29.36^{ab}$ |
| $T_3$: | Paclobutrazol | $30.57^{a}$ |
| $T_4$: | (1-2-chloro-4pyridyl-3-phenyl urea) | $20.88^{b}$ |
| $T_5$: | Zinc Sulphate+Gibberilic acid | $24.32^{b}$ |
| $T_6$: | Zinc Sulphate+Napthalein Acetic Acid | $24.97^{b}$ |
| $T_7$ : | Zinc Sulphate+Paclobutrazol | $26.61^{ab}$ |
| $T_8$ : | Zinc Sulphate+1-2-chloro-4pyridyl-3-phenyl urea | $25.52^{ab}$ |
| $T_9$ : | Potassium Sulphate +Gibberilic acid | $24.34^{b}$ |
| $T_{10}$ : | Potassium Sulphate +Napthalein Acetic Acid | $26.96^{ab}$ |
| $T_{11}$ : | Potassium Sulphate +Paclobutrazol | $25.66^{ab}$ |
| $T_{12}$: | Potassium Sulphate +1-2-chloro-4pyridyl-3-phenyl urea) | $25.46^{ab}$ |
| $T_{13}$: | Control | $19.30^{b}$ |
| **F- test** | | * |
| **S.Em ±** | | 2.07 |
| **CD at (5%)** | | 6.09 |

Figures with same alphabets did not differ significantly.

** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.

Values were compared with respective C.D values

**Table 3: Effect of Combination of Bioregulators and Growth Regulator Sprays on Panicle Breadth of Mango Cv. Banganpalli**

| Treatment | | Mean |
|---|---|---|
| $T_1$: | Gibberilic acid | $9.25^{c}$ |
| $T_2$: | Napthalein Acetic Acid | $14.20^{bc}$ |
| $T_3$: | Paclobutrazol | $22.20^{a}$ |
| $T_4$: | (1-2-chloro-4pyridyl-3-phenyl urea) | $11.40^{c}$ |
| $T_5$: | Zinc Sulphate+Gibberilic acid | $12.98^{b}$ |
| $T_6$: | Zinc Sulphate+Napthalein Acetic Acid | $17.06^{b}$ |
| $T_7$ : | Zinc Sulphate+Paclobutrazol | $18.51^{ab}$ |
| $T_8$ : | Zinc Sulphate+1-2-chloro-4pyridyl-3-phenyl urea | $21.82^{ab}$ |
| $T_9$ : | Potassium Sulphate +Gibberilic acid | $10.53^{c}$ |
| $T_{10}$ : | Potassium Sulphate +Napthalein Acetic Acid | $16.41^{bc}$ |
| $T_{11}$ : | Potassium Sulphate +Paclobutrazol | $16.6^{bc}$ |
| $T_{12}$: | Potassium Sulphate +1-2-chloro-4pyridyl-3-phenyl urea) | $15.87^{bc}$ |
| $T_{13}$: | Control | $8.33^{c}$ |
| **F- test** | | * |
| **S.Em ±** | | 1.51 |
| **CD at (5%)** | | 4.45 |

Figures with same alphabets did not differ significantly.

** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.

Values were compared with respective C.D values.

**Table 4: Effect of Combinations of Bioregulators and Growth Regulator Sprays on Fruit Set Per Panicle of Mango Cv. Banganpalli**

| Treatment | | Mean |
|---|---|---|
| $T_1$: | Gibberilic acid | 8.86$^{b}$ |
| $T_2$: | Napthalein Acetic Acid | 9.06$^{b}$ |
| $T_3$: | Pachlobutrazol | 13.13$^{a}$ |
| $T_4$: | (1-2-chloro-4pyridyl-3-phenyl urea) | 9.26$^{b}$ |
| $T_5$: | Zinc Sulphate+Gibberilic acid | 10.13$^{ab}$ |
| $T_6$: | Zinc Sulphate+Napthalein Acetic Acid | 8.20$^{b}$ |
| $T_7$: | Zinc Sulphate+Pachlobutrazol | 8.43$^{b}$ |
| $T_8$: | Zinc Sulphate+1-2-chloro-4pyridyl-3-phenyl urea | 13.00$^{a}$ |
| $T_9$ : | Potassium Sulphate +Gibberilic acid | 10.86$^{ab}$ |
| $T_{10}$ : | Potassium Sulphate +Napthalein Acetic Acid | 11.33$^{ab}$ |
| $T_{11}$ : | Potassium Sulphate +Pachlobutrazol | 12.80$^{ab}$ |
| $T_{12}$: | Potassium Sulphate +1-2-chloro-4pyridyl-3-phenyl urea) | 8.33$^{b}$ |
| $T_{13}$: | Control | 8.00$^{b}$ |
| **F- test** | | * |
| **S.Em ±** | | 1.24 |
| **CD at (5%)** | | 3.62 |

Figures with same alphabets did not differ significantly.

** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.

Values were compared with respective C.D values

**Table 5: Effect of Combination of Bioregulators and Growth Regulators Sprays on Fruit Number of Mango Cv. Banganpalli**

| Treatment | | Mean |
|---|---|---|
| $T_1$: | Gibberilic acid | 113.00$^{c}$ |
| $T_2$: | Napthalein Acetic Acid | 126.00$^{b}$ |
| $T_3$: | Paclobutrazol | 133.00$^{a}$ |
| $T_4$: | (1-2-chloro-4pyridyl-3-phenyl urea) | 131.66$^{ab}$ |
| $T_5$: | Zinc Sulphate+Gibberilic acid | 112.33$^{c}$ |
| $T_6$: | Zinc Sulphate+Napthalein Acetic Acid | 120.66$^{b}$ |
| $T_7$: | Zinc Sulphate+Paclobutrazol | 131.33$^{ab}$ |
| $T_8$: | Zinc Sulphate+1-2-chloro-4pyridyl-3-phenyl urea | 122.66$^{b}$ |
| $T_9$ : | Potassium Sulphate +Gibberilic acid | 126.00$^{b}$ |
| $T_{10}$ : | Potassium Sulphate +Napthalein Acetic Acid | 123.33$^{b}$ |
| $T_{11}$ : | Potassium Sulphate +Paclobutrazol | 130.00$^{ab}$ |
| $T_{12}$: | Potassium Sulphate +1-2-chloro-4pyridyl-3-phenyl urea) | 123.33$^{b}$ |
| $T_{13}$: | Control | 110.66$^{c}$ |
| **F- test** | | * |
| **S.Em ±** | | 2.29 |
| **CD at (5%)** | | 6.68 |

Figures with same alphabets did not differ significantly.

** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.

Values were compared with respective C.D values

**Table 6: Effect of Combination of Bioregulators and Growth Regulator Sprays on Fruit Weight of Mango Cv. Banganpalli**

| Treatment | | Mean |
|---|---|---|
| $T_1$: | Gibberilic acid | 301.00[bc] |
| $T_2$: | Napthalein Acetic Acid | 315.67[a] |
| $T_3$: | Paclobutrazol | 309.33[ab] |
| $T_4$: | (1-2-chloro-4pyridyl-3-phenyl urea) | 299.67[bc] |
| $T_5$: | Zinc Sulphate+Gibberilic acid | 301.67[bc] |
| $T_6$: | Zinc Sulphate+Napthalein Acetic Acid | 297.33[bc] |
| $T_7$: | Zinc Sulphate+Paclobutrazol | 309.00[ab] |
| $T_8$: | Zinc Sulphate+1-2-chloro-4pyridyl-3-phenyl urea | 305.33[bc] |
| $T_9$: | Potassium Sulphate +Gibberilic acid | 306.33[b] |
| $T_{10}$: | Potassium Sulphate +Napthalein Acetic Acid | 307.33[ab] |
| $T_{11}$: | Potassium Sulphate +Paclobutrazol | 299.33[bc] |
| $T_{12}$: | Potassium Sulphate +1-2-chloro-4pyridyl-3-phenyl urea) | 309.00[ab] |
| $T_{13}$: | Control | 296.67[c] |
| **F- test** | | * |
| **S.Em ±** | | 3.10 |
| **CD at (5%)** | | 9.05 |

Figures with same alphabets did not differ significantly.

** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.

Values were compared with respective C.D values

**Table 7: Effect of Combination of Bioregulators and Growth Regulator Sprays on Yield (Kg per Tree) of Mango of Mango Cv. Banganpalli**

| Treatment | | MEAN | Percentage (%) Increase in Yield Over Control |
|---|---|---|---|
| $T_1$: | Gibberilic acid | 34.01[e] | 3.62 |
| $T_2$: | Napthalein Acetic Acid | 39.7[ab] | 20.96 |
| $T_3$: | Paclobutrazol | 40.6[a] | 23.70 |
| $T_4$: | (1-2-chloro-4pyridyl-3-phenyl urea) | 39.45[b] | 20.20 |
| $T_5$: | Zinc Sulphate+Gibberilic acid | 34.74[e] | 5.85 |
| $T_6$: | Zinc Sulphate+Napthalein Acetic Acid | 35.87[d] | 9.35 |
| $T_7$: | Zinc Sulphate+Paclobutrazol | 39.61[ab] | 20.68 |
| $T_8$: | Zinc Sulphate+1-2-chloro-4pyridyl-3-phenyl urea | 37.9[c] | 15.48 |
| $T_9$: | Potassium Sulphate +Gibberilic acid | 38.59[bc] | 17.60 |
| $T_{10}$: | Potassium Sulphate +Napthalein Acetic Acid | 37.87[c] | 15.39 |
| $T_{11}$: | Potassium Sulphate +Paclobutrazol | 38.91[bc] | 18.55 |
| $T_{12}$: | Potassium Sulphate +1-2-chloro-4pyridyl-3-phenyl urea) | 38.11[c] | 16.12 |
| $T_{13}$: | Control | 32.82[f] | |
| **F- test** | | * | |
| **S.Em ±** | | 0.38 | |
| **CD at (5%)** | | 1.11 | |

Figures with same alphabets did not differ significantly.

** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.

Values were compared with respective C.D values

## CONCLUSIONS

Among the bioregulators and growth regulator sprays, highest yield was recorded in paclobutrazol (23.7 % over control) alone applied trees compare to control. Napthalene acetic acid (NAA) spray alone has increased the yield up to 20.96 % over control was effective in improving the yield of mango. Zinc sulphate+ paclobutrazol application has increased the yield up to 20.68 % over control and (1-2-chloro-4pyridyl-3-phenylurea) application has increased the yield up to 20.20% over control. Hence, paclobutrazol and NAA alone were equally effective in improving the yield when compared to bioregulators, growth regulators sprayed in other combinations.

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